Proposed Amendments to the Verification Procedure for In-Use Strategies to Control Emissions from Diesel Engines

March 23, 2006

Public Hearing

California Environmental Protection Agency

Air Resources Board

Background
Verification Procedure

- Diesel Risk Reduction Plan Adopted Oct 2000
- Major Objective: Clean-up In-use Diesel Engines Through Retrofit or Replacement
- Verification Required for Retrofit Control Devices to Assure They Work In-use
  - Emission testing (pre-verification)
  - Compliance testing (post-verification)
  - Warranty
  - Limit on amount of NO_2 emitted (20% of NOx, max.)
    - Prevents increases in ambient ozone & NO_2 exceedances

Status

- Diesel Clean-up Underway
  - Eight in-use regulations adopted
  - 1000’s of retrofit devices installed
  - Number of verified devices growing
- NO_2 Limit Delayed from 2004 to 2007
  - Most devices didn’t meet 20% limit
  - New deadline to meet 20% limit approaching
  - Problems with “form” of the limit

NO_2 and Diesel Retrofits

- Today's Most Commonly Used Filters Rely on NO_2 to Burn Off Collected Diesel PM
  - Catalyst oxidizes NO in exhaust to NO_2
  - More NO_2 production makes a filter less likely to plug and appropriate for use in a wider range of applications
- But more NO_2 can increase air pollution
  - NO_2 limit helps mitigate adverse impacts

Why We Care About NO_2

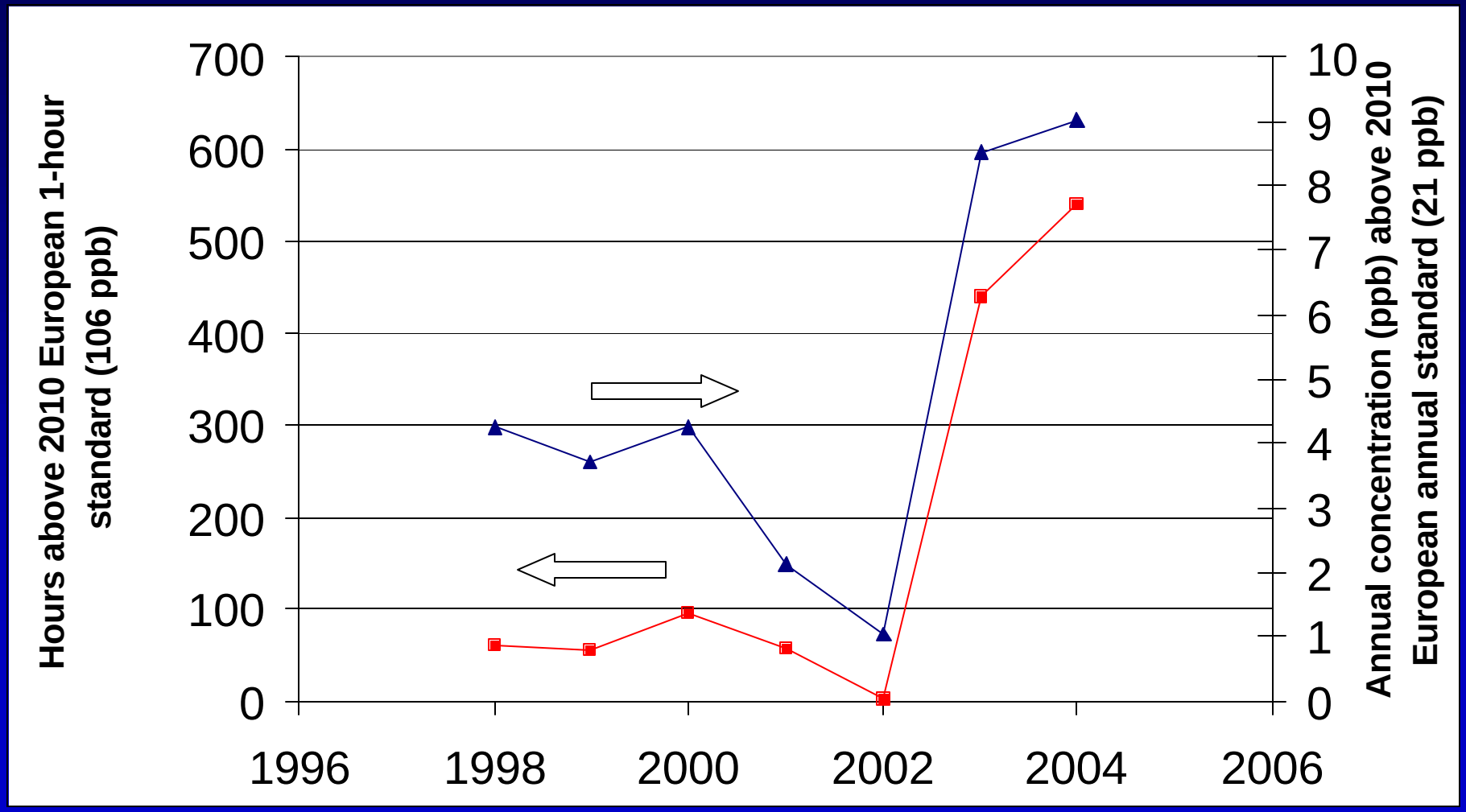
- Elevated NO_2 Emissions Can Increase Exposure to Three Ambient Pollutants:
  - Secondary Nitrate PM ($PM_{2.5}$)
  - Ozone (O_3)
  - NO_2
- California is Non-attainment for Two: Ozone and PM
- California is Attainment for Ambient NO_2
  - But, increased ambient NO_2 observed in European cities where catalyzed PM controls widely used

Ambient NO_2 in Europe
Example

- London, England
  - Roadside data: NOx ?, NO_2 constant on average
  - Significant NO_2 increases on some roads
  - Attributed to buses retrofitted with high-NO_2 filters and growing share of diesel cars

London Roadside NO_2 Data

Marylebone Road (heavy bus traffic)



(Carslaw, 2005)

California vs. Europe

- Situation in California is Different
  - Fewer retrofitted vehicles and diesel cars at present, but expected to increase in the future
  - California limits NO_2 emissions from retrofits (Europe does not)
  - Filter retrofits in Europe are predominantly the design with the highest NO_2 emissions

The Current NO_2 Limit (Effective 1/2007)

- A Retrofit May Not Cause an Engine's NO_2 Emissions to Exceed a Level Equivalent to 20% of the Engine's NOx Emissions
- Becomes Effective January 1, 2007
- Staff Believes this NO_2 Limit Needs to Be Revised

Technology Update

- Most Verified Filters Do Not Meet the Current NO_2 Limit
  - Would be de-verified on January 1
- The Exception: Uncatalyzed Filters
  - Two “electrical plug-in” filters have been verified
  - Typically limited to centrally-stationed fleets
- Lack of high-efficiency retrofit devices would stall achievement of Diesel Risk Reduction Plan goals

Proposed NO_2 Limit

- Limit the Increase in NO_2 Over the Baseline Level:

Effective Date	Maximum Increase (as % of baseline NOx)
Jan 1, 2007	30%[1]
Jan 1, 2009	20%

[1] Previous limit allowed ~10-15% increase

Analysis of Predicted Impacts

- Air Quality
  - PM: Net decrease in $PM_{2.5}$ (SoCAB model)
  - Ozone: Small increase in exposure (SoCAB model)
  - NO_2: Increases, but below 1-hr std (near-source)
- Number of Verified Retrofits
  - No broadly-applicable filters under current limit
  - Most filters remain verified under proposed limit

Air Quality Impact Estimates

Pollutant	$PM_{2.5}$*	Ozone*	NO_2**
Exposure	Decreases	Increases 1-2 ppb O_3	Increases
Annual Health Impacts	240 premature deaths avoided	Equiv. to 10-30 tpd HC increase; + 1-2 premature deaths	Exposure remains below 1-hr CA std

* SoCAB, 2010

** Various near-source scenarios

- Significant reductions in premature deaths
  - If no action taken, benefit cut in half in 2010
- Slight increase in ozone exposure
- Increase in NO_2 exposure but still below the California 1-hr ambient standard

Compliance of Verified Systems

PM Level	Verified System	Complies with existing limit
Level 3 (85% PM reduction)	1	+
	2	+
	3	--
	4	--
	5	--
	6	--
	7	--
	8	--
	9	--
	10	--
	11	--
	12	--
Level 2 (50% PM reduction)	1	--
	2	--
	3	unknown
	4	unknown
Level 1 (25% PM reduction)	All 9 Systems	+

Estimates for Compliance of Verified Systems

PM Level	Verified System	Complies with existing limit	Complies with proposed 30% increase (2007)
Level 3 (85% PM reduction)	1	+	+
	2	+	+
	3	--	+
	4	--	+
	5	--	+
	6	--	+
	7	--	+
	8	--	+
	9	--	+
	10	--	--
	11	--	--
	12	--	--
Level 2 (50% PM reduction)	1	--	+
	2	--	+
	3	unknown	unknown
	4	unknown	unknown
Level 1 (25% PM reduction)	All 9 Systems	+	+

Estimates for Compliance of Verified Systems

PM Level	Verified System	Complies with existing limit	Complies with proposed 30% increase (2007)	Complies with proposed 20% increase (2009)
Level 3 (85% PM reduction)	1	+	+	+
	2	+	+	+
	3	--	+	+
	4	--	+	--
	5	--	+	--
	6	--	+	--
	7	--	+	--
	8	--	+	--
	9	--	+	--
	10	--	--	--
	11	--	--	--
	12	--	--	--
Level 2 (50% PM reduction)	1	--	+	+
	2	--	+	--
	3	unknown	unknown	unknown
	4	unknown	unknown	unknown
Level 1 (25% PM reduction)	All 9 Systems	+	+	+

Other Proposed Amendments

- New “Plus” Verification Levels
  - Systems that meet the 2009 NO_2 limit early will be designated by a “Plus”

Classification	PM Reduction	Max NO_2 Increase (2009 compliant)
Level 3 Plus	$\geq$ 85%	20%
Level 2 Plus	$\geq$ 50%	
Level 1 Plus	$\geq$ 25%	

Other Proposed Amendments

- More Accurate NO_2 Measurements
  - Additional pre-conditioning requirements
  - Test engine NO_2 limit
- Three Minor Amendments

Issue

- **“Plus” Level Designation**
  - Can be used to encourage use of low-NO_2 systems
  - Could define BACT, preventing use of many available retrofit devices
  - Focuses only on NO_2
    - Low NO_2 devices may not reduce hydrocarbons, toxics as well

Recommendations

- Adopt Proposed Amendments
- As Technology Evolves, Reevaluate NO_2 Limit As Necessary
- Closely Monitor Ambient NO_2 As More Diesel Retrofits Are Installed